OPERATING INSTUCTIONS

FOR

TRIPLETT MODEL 1696-A MODULATION MONITOR

THE TRIPLETT ELECTRICAL INSTRUMENT Co.

MANUFACTURERS OF

PRECISION MEASURING INSTRUMENTS

BLUFFTON, OHIO

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TRIPLETT

OPERATING INSTRUCTIONS

MODEL 1696-A
MODULATION MONITOR

The Model 1696-A Modulation Monitor is designed to operate from a 100 to 130 volt, 60 cycle Alternating Current supply and when properly coupled to a radio phone transmitter will measure the percentage of modulation in Peak Volts on a sine wave signal. The transformer primary has a terminal strip marked "105, 115 and 125 volts". The nominal line voltage that the Monitor will be used on, should be checked before installation is made and the lead moved over to the lug nearest the line voltage reading while the station is in operation. The power consumption from the line at 115 volts is 27 Watts.

The instrument is shipped for operation on 115 volts, 60 cycle A. C. and the transformer is connected at the 115 volt primary tap.

Operating frequencies up to 30 megacycles can be handled with the internal resistance control. Above this frequency the input control should be turned to the extreme right so as to be out of the circuit and the input (carrier level) controlled by special coupling systems depending on the individual installation.

The R. F. or Carrier Level Meter has a dial reading 0-200 and the normal setting is at midscale or the 100 point. This reading is adjustable by the Carrier Level control located at the lower left hand corner of the panel, directly beneath the meter.

The instrument is designed to measure both the Positive and Negative Peaks. The Positive Peaks are normally used and reference to the Negative Peaks is for checking the symmetry of the emitted wave. Any discrepancy in the wave form will be evidenced by a change in reading on the Carrier Level or the Modulation Meters, or both.

A Neon lamp is provided at the upper center of the panel to show when the Modulation exceeds the pre-set level, as controlled by the "FLASH % MODULATION" control immediately below this lamp. The purpose of the Neon Lamp is to indicate Modulation Peaks of very short duration which cannot be followed by the instrument pointer due to physical limitations caused by the inertia of the moving parts. The movement requires approximately 300 Milliseconds for 100% deflection.

The "FLASH % MODULATION" control is scaled from 40 to 120% Modulation with a calibrating control labeled "NEON CALIBRATION" im-

mediately to the right of it. This scale is used in connection with the Neon lamp only and has no bearing on the Percent Modulation Meter. The scale calibration is based on averages and may not track at all points due to variations in the potentiometer itself. To accurately set this a steady signal of sufficient intensity to make the Modulation Meter read up to the point desired should be applied to the transmitter, then the "FLASH % MODULATION" control is set to read the same as the Modulation Meter and the Neon calibration control is rotated until the lamp just begins to glow. This individual calibration gives the operator control as to how bright the Neon lamp should flash if his pre-set limit has been exceeded. An example of this setting would be as follows:

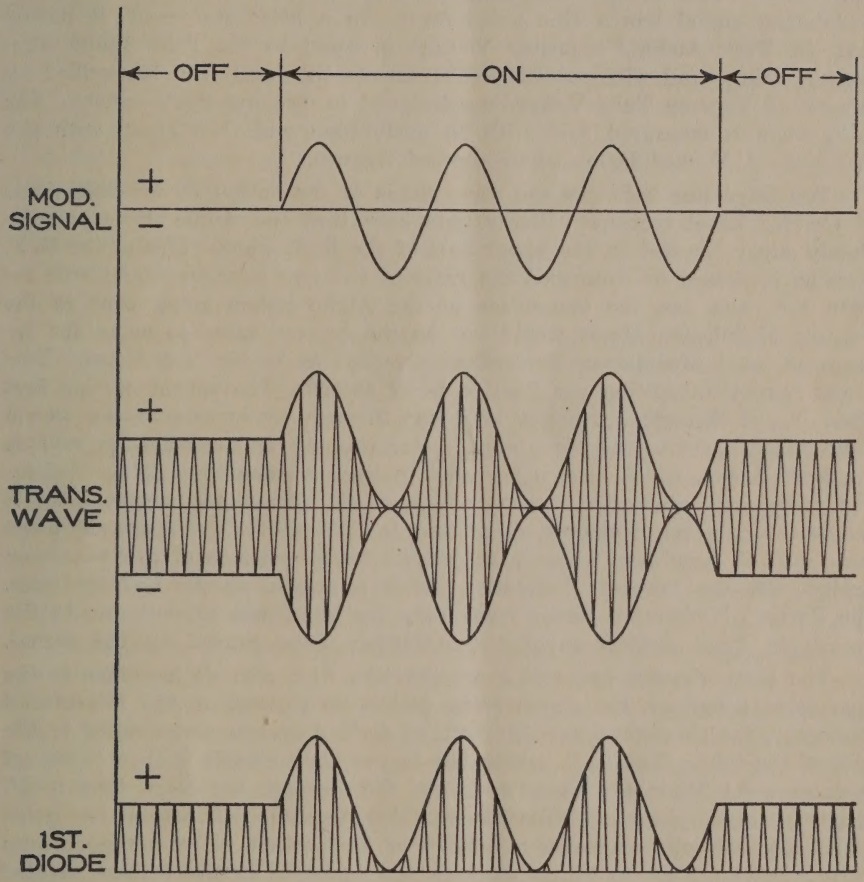
The Modulation level not to be exceeded is decided as 80%. The "FLASH % MODULATION" control is set at 80, and a signal applied to the transmitter—its intensity varied until the Modulation Meter reads 80. The Neon calibration control is adjusted until the Neon lamp begins to glow. With this setting it is safe to operate the transmitter by merely watching the Neon lamp for over-modulation, taking the average instrument readings for normal monitoring.

The Percent Modulation Meter is located at the upper right hand corner of the panel and reads correctly only when the Carrier Level Meter has been adjusted to 100, the midscale point, and balanced to zero with no modulation by the "ZERO MOD. BALANCE" control. An example of this setting follows:

With the Monitor connected to the Alternating Current supply and no connections to the Input jacks the "ZERO MOD. BALANCE" control is rotated until the pointer on the Percent Modulation Meter reads zero. This adjustment compensates for any variation in line voltage as well as any resistance changes in the unit due to variation in temperature. This method was chosen because automatic compensation would run the cost of production to a prohibitive figure and replacement tubes would have to be pre-calibrated or the Monitor sent in for installation of new ones. It is not necessary to return the Monitor for tube replacements.

Before installing the Model 1696-A Modulation Monitor the following brief review of the principles involved in Modulation Measurements as well as the theory of operation of the unit itself will compensate the reader for his time in more satisfactory operation and a better understanding of the results obtained under various conditions.

The following graph represents a 100% modulated signal as emitted by a correctly adjusted transmitter and a sine wave input to the speech equipment.


OFF
ON
OFF
MOD. SIGNAL
+
−
TRANS. WAVE
+
−
1ST. DIODE
+

The first graph shows the wave form and the time of the modulating current. This may be obtained by a steady note through the microphone or directly from a 60 cycle transformer supplying a constant voltage.

The second line shows the unmodulated radio frequency wave as emitted by the antenna as well as the modulated wave during the time the signal is modulating the transmitter. A 100% modulated radio frequency wave is shown. Note that the Positive Peaks are two times as high as the original R. F. Peaks and the Negative Audio Peaks are down to the base line of the R. F. wave. This is the theoretical base for 100% modulation where the modulating signal has a sine wave form. In a brief statement, it means that the Peak Audio Frequency Voltage is equal to the Peak Radio Frequency voltage and with careful measurements the result can be verified by the use of Vacuum Tube Voltmeters designed to measure Peak values. The R. F. wave is measured first with no modulation and then again with the sine wave A. F. modulation super-imposed thereon.

The third line indicates the wave shape of the output of the first diode or Carrier Level rectifier. Please note here that the Audio wave is completely super-imposed on the upper half of the R. F. wave. Should the R. F. level be increased or decreased the ratio of the two voltages would still remain the same but the magnitude of the Audio pulses going over to the Percent Modulation Meter would not be the correct value to make the instrument read Modulation Percentage directly, as it was calibrated. This is the reason for setting the Carrier Level at 100. The output of this first diode is put through a resistor and sent through condensers to the second diode which operates the Modulation meter through an amplifier, as well as the Neon Lamp, which is also operated through an amplifier. The Modulation meter reads only the Audio portion of the first diode output after it passes through the condenser, diode and D. C. Amplifier. The second diode feeds a D. C. Amplifier, whose plate circuit forms one arm of a Wheatstone Bridge with the Percent Modulation Meter connected as the Galvanometer. The Percent Modulation Meter reads only the unbalance current due to the change in Plate Resistance of the Amplifier Tube caused by the signal.

The Neon Flasher operates in conjunction with pentode amplifier in the conventional manner, the signal being picked up through a .025 Microfarad condenser, fed through a variable voltage divided system and applied to the grid of the tube. The A. C. component in the plate circuit is then taken off through a 0.1 Microfarad condenser and fed through the Neon tube itself. Inspection of the diagram will show that this Amplifier operates at one point on its characteristic curve for all values of Modulation. The voltage pickup setting is so related to the amount of A. F. present in the voltage divided system that the same value is fed to the grid for any percentage of modulation within the operating range. This circuit allows the interchange of tubes without offecting the calibration more than can be compensated for by the "NEON CALIBRATION" control.

The "NEON CALIBRATION" control is a variable bias resistor for the 6D6 and changes the sensitivity of the tube so that the Flash control setting can be made to coincide with the Modulation Meter reading.

The Neon Lamp is located in a partly shielded compartment to avoid as much stray pickup as possible.

The "ZERO MOD. BALANCE" controls the bias on the second half of the 6C8G tube, connected as a triode in a D. C. Amplifier circuit, thereby adjusting the plate resistance to balance the bridge formed by the 588,000, 132,500 and 50,000 ohm resistors as the other three legs.

A return delay circuit for the instrument is incorporated in the diode of the 6C8G and consists of a 5 megohm resistor paralleled by a .025 Microfarad condenser—the theory of operation being that the signal charges the condenser to a given voltage and the discharge time is made long enough, by the high resistance across it, to hold the instrument up to its original reading for a short time. The condenser and resistor combination has been proportioned to give the best overall accuracy for speech or steady signals.

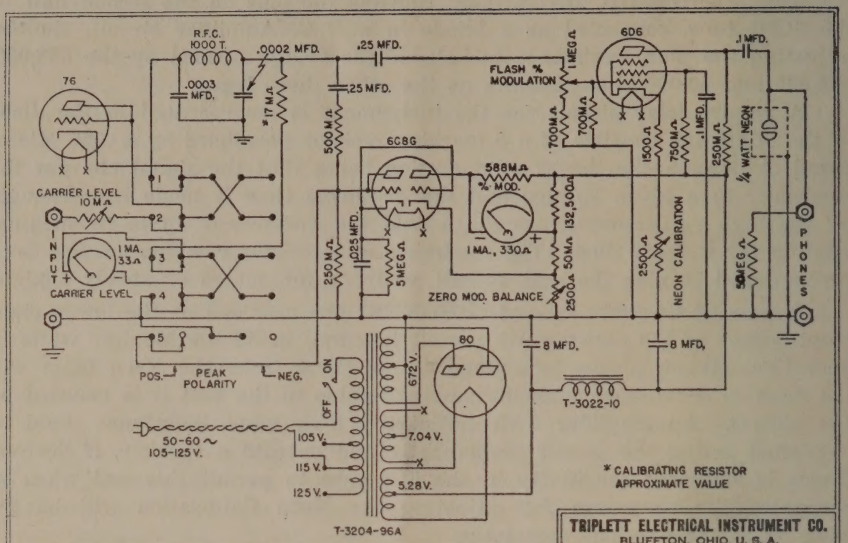
A pair of tip jacks labeled "PHONES" are provided at the lower right hand corner of the panel which permit listening in on the Monitor while in operation. When phones are plugged into these jacks the Neon lamp will not flash in accordance with its calibration due to the fact it is shunted by the phones. An amplifier with sufficiently high input impedance could be connected across the circuit permanently and operate a speaker, if desired. There is sufficient sensitivity in the 6D6 tube to permit this and when so connected the procedure for adjusting the Neon Calibration will be the same as in the previous description.

The readings of any Modulation Monitor as well as the 1696-A will be in error if the transmitter adjustment is incorrect and an unsymmetrical wave is radiated. This will be evidenced by a shift in the Carrier Level reading when the "POLARITY" switch is changed from Positive to Negative position. However, this does not always hold true because any D'Arsonval movement in connection with a rectifier will read Average values whereas Modulation theory is based on Peaks. It is impractical to design a Modulation Monitor with a direct reading instrument which will follow Peaks faithfully. Monitors responding to Peak values can, however, be built and used for Laboratory measurements under a more or less fixed condition allowing sufficient time for balancing two Vacuum Tube Voltmeters.

Modulation Monitors employed in Broadcast Stations at the present time use indicating type instruments which respond to Average values. The instruments in the Model 1696-A are calibrated on sine wave current where the Peak is known to be 1.41 times the R. M. S. value and on average wave forms will give readings accurate enough for practical purposes. The assumption is that if a Peak of one one-thousandth of a second is emitted beyond the 100% Modulation point and spaced sufficiently far apart no audible interference will result—the major requirement being that the average modulation should be held below 100%. By setting the Monitor to a safe value below the 100% point, where good efficiency still results in the transmitting equipment, compliance with F. C. C. Regulations as regards amplitude Modulation should be an easy matter.

The toggle switch at the center of the panel marked "LINE" has been placed in the primary power circuit to allow all other settings of the Monitor to be left as previously adjusted thereby saving time when operation is resumed.

Facilities are provided for grounding the case on the Monitor by connecting to the self-tapping screw on the back of the case. This ground con-


R.F.C. 1000 T.
.0002 MFD.
.25 MFD.
.0003 MFD.
.25 MFD.
17 M.A.
76
6D6
6C8G
FLASH % MODULATION
1 MEG Ω
700 M.A.
700 M.A.
1500 Ω
750 M.A.
250 M.A.
.1 MFD.
1 MFD.
¼ WATT NEON
CARRIER LEVEL 10 M.A.
INPUT
1 MA. 33 Ω
CARRIER LEVEL
500 M.A.
250 M.A.
.025 MFD.
5 MEG Ω
588 M.A. % MOD.
1 MA., 330 Ω
132,500 Ω
50 M.A.
2500 Ω
2500 Ω
NEON CALIBRATION
50 MEG Ω
PHONES
ZERO MOD. BALANCE
80
8 MFD.
8 MFD.
T-3022-10
POS.
PEAK POLARITY
NEG.
OFF ON
672 V.
50-60 ~ 105-125 V.
105 V.
115 V.
125 V.
7.04 V.
5.28 V.
T-3204-96A
* CALIBRATING RESISTOR APPROXIMATE VALUE
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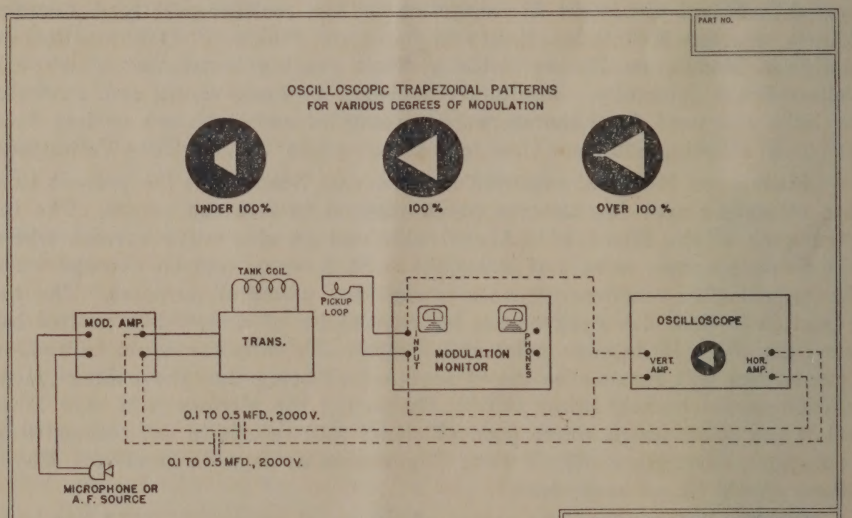
No. REVISION BY DATE
1696-A CIRCUIT DIAGRAM
MAT.
DRAWN BY KT
DATE 2-16-40
CHECKED BY H.S.
APPROVED BY Rinde
PART NO.


PART NO.
OSCILLOSCOPIC TRAPEZOIDAL PATTERNS
FOR VARIOUS DEGREES OF MODULATION
UNDER 100%
100 %
OVER 100 %
TANK COIL
PICKUP LOOP
MOD. AMP.
TRANS.
INPUT
MODULATION MONITOR
MONITOR
OSCILLOSCOPE
VERT. AMP.
HOR. AMP.
0.1 TO 0.5 MFD., 2000 V.
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No. REVISION BY DATE
INSTALLATION AND TEST DIAGRAMS FOR
~~MET.~~ MODEL 1696 MODULATION MONITOR
DRAWN BY KT
DATE 9-17-39
CHECKED BY H.S.
APPROVED BY Rinde
PART NO.

nection should be employed at all times as under some conditions, when not grounded, the case will accumulate quite an R. F. charge and cause a burn when touched by the operator. This precaution will also prevent possible injury to operator if the pickup coil should accidentally short to the tank coil.

Some recent articles on microphone polarities show that the male voice in conjunction with standard microphones will have unsymmetrical wave shapes whereby the voltage below the reference line is considerably less than that above the reference line or vice versa. To take full advantage of this fact the microphone could be so connected that the upper half, or the positive half, of the voice wave is the larger of the two. This point should also be kept in mind when making checks on modulation performance of the amplifiers as well as the equipment used for making these measurements. The fact that the Positive and Negative Peaks did not match up during modulation measurements has prompted more than one inquiry on the subject, some of them being in the form of complaints unjustly charging discrepancies to the Monitor.

INSTALLATION

1) Place the Monitor in its permanent place on the operating table.

2) Measure the voltage at the outlet the Monitor is to be connected to, (if the transmitter load effects this voltage, take the reading while the transmitter is on and fully modulated). If the line voltage reading is found is be less than 110 or more than 120 the Monitor should be removed from the case and the line cord lead connected to the lug bearing a voltage mark nearest to the line voltage readings obtained. This, of course, is done before the Monitor is connected to the outlet. If the voltage is between 110 and 120, the proper connection (115) is already made at the factory and need not be changed.

3) Connect the case of the Monitor to the nearest ground.

4) Set both meter pointers to zero if necessary.

5) Before connecting any R. F. to the Monitor plug the line cord into the outlet and turn the "LINE" switch to the "ON" position. The green pilot lamp should light, indicating that the line voltage to the Monitor has been turned on.

6) After the tubes have been allowed to warm up, adjust the "ZERO MOD. BALANCE" so that the Per cent Modulation Meter reads zero. This zero should correspond with the mechanical zero of the instrument, made as per section 4, the latter being tested when the Monitor has been turned off long enough to allow all tubes to cool.

7) Set the controls as follows, preparatory to making a pickup connection to the Oscillator Tank circuit of the transmitter. The "CARRIER LEVEL" control should be set at approximately 80, the "PEAK POLARITY" control should be set on Positive, the "FLASH % MODULATION" should be set on 80, the "Neon CALIBRATION" at approximately 50 (this will have to be adjusteed after the Monitor is in operation), the "ZERO MOD. BALANCE" should not be disturbed after it has once been set in accordance with the instructions outlined in Section 6.

8) Connect a five to six turn pickup loop to the Input jacks of the Monitor and with a long stick of well dried wood or a piece of fibre tubing

gradually bring this coil closer to Tank circuit in the transmitter (after it has been turned on) until the Carrier Level Instrument on the left hand side reads in the neighborhood of 100 at the midscale point.

9) Turn off the transmitter and attempt to make a permanent installation of this pickup loop so that it will not vary and cause erroneous indications during transmission. The leads furnished are seldom long enough for the job but the plugs can be installed on any other type of wire used or a longer lead can be spliced on to their ends.

10) During the time the R. F. connections and the pickup coil coupling is being adjusted it is very important that the Monitor be turned on and in operating condition so that the gradual increase of R. F. energy in the pickup circuit will be indicated and overloading avoided.

11) With the pickup loop and leads permanently installed the transmitter should again be turned on and after allowing sufficient time for both the transmitter and the Monitor to deliver normal voltages at the power packs adjust the "CARRIER LEVEL" control until the Carrier Level Meter reads 100, with no modulation.

12) Recheck the Zero Modulation Balance by disconnecting the Input leads at the monitor, and re-adjust if necessary.

13) After reconnecting the leads a steady whistle into the microphone should make the Percent Modulation Meter read and when the 80 point is reached readjust the "NEON CALIBRATION" control until the Neon Lamp just begins to glow with the "FLASH % MODULATION" control set at 80, as previously directed.

14) Change the "FLASH % MODULATION" control to 90 and again whistle into the microphone until the Percent Modulation Meter indicates 90. For a small change in modulation the Flash scale will track and the Neon Lamp should start to flash as soon as the 90% point is passed on the meter.

15) With the settings as outlined in the last instruction, an intermittent whistling into the microphone of different time duration will indicate the difference in response of the Neon Lamp as compared to the Percent Modulation Meter. This information is to be used later for developing a technique of monitoring along the lines used in Broadcast Stations.

16) To test the over-modulation carrier shift, a dummy antenna, as used in tuning up the transmitter, should be connected in place of the standard antenna equipment and the whistle into the microphone increased in volume until the Percent Modulation Meter goes beyond the 100 point. Observe the Carrier Level Meter shifting from the 100 point as soon as 100% Modulation is exceeded.

17) Switch the "PEAK POLARITY" control to the Negative side and again whistle into the microphone and notice the Carrier Level shift as the 100% modulation is exceeded.

18) If a step-down transformer is connected to the 60 cycle line and to the speech equipment, in place of a microphone, the above study on over-modulation will be under better control, and, due to the fact that the wave shape will be known to be very close to a sine wave, (if taken from a public service line), any difference in readings will not be due to the modu-

lating current wave shape. Any discrepancy in the readings of the Carrier Level Meter when this polarity shift is made will indicate poor adjustment of the transmitter and the usual methods of checking output should be resorted to before further operation is attempted. A mis-aligned and poorly adjusted transmitter always results in lowered efficiency from an operating standpoint.

20) Should it become desirable to mount this Monitor on a rack and panel system the four screws at the top and four screws at the bottom of the panel should be removed and used to hold the Monitor to whatever size panel is desired. The use of the case itself on back as a dust cover is, of course, optional. The hole in the rack panel should be cut just large enough to pass the operating parts of the Monitor without disassembling it so that sufficient material is left for fastening the main panel of the 1696-A thereto.

20) A diagram is included showing the fundamental connections for checking Modulation with an Oscilloscope. However, the readings of the Oscilloscope are not absolute and in general an accuracy of 10% results in such measurements. The Oscilloscope is not recognized as a final authority on Modulation Measurements at Broadcast Stations.

21) A further check on the accuracy of the Modulation Monitor can be made by a comparison of the unmodulated as well as modulated Peaks of the emitted wave by the use of Vacuum Tube Voltmeters across a standard load. This load, of course, should be non-reactive and extreme precaution should be taken to avoid stray pickup and other errors from entering into the measurement.

When complex speech waves are used for modulation the meter reads the average but the Neon bulb will indicate excess peaks. This is the reason for using sine wave or a whistle (which is close enough for practical purposes) when setting the Neon calibration control as per section 13.

Attempts have been made to make these instructions as complete as possible but if you find it necessary to write, please give all the pertinent data to enable the Engineering Department to analyze your problem as quickly and efficiently as possible.

The Triplett Electrical Instrument Company

BLUFFTON, OHIO, U. S. A.

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